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## ANTHROPOLOGY

### SERiation OF CERTAIN ARIKARA VILLAGES

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#### ABSTRACT

Selected villages of 18th century Arikara Indians are seriated on the basis of presumably sensitive pottery traits. Two agreeing temporal models, one statistical and one graphical, are derived from the manipulated data. The statistical model is further abstracted to present a relative temporal placement of the individual villages. The models and their interpretations differ somewhat from previous work on the subject. Certain ideas regarding modification of the techniques employed are discussed. A few thoughts are also injected regarding the use of temporal models, seriation, and statistics in general for the interpretation of past behavior.

#### SERiation OF CERTAIN ARIKARA VILLAGES

Twenty years of salvage archeology in the Middle Missouri region of North and South Dakota have produced a wealth of raw data on the material culture of the prehistoric and early historic inhabitants. Most of the archeology stems from the numerous village sites of peoples considered to be ancestral to Arikara and Mandan/Hidatsa Indians. The general outlines of the regional culture history have been established for some time (Lehmer, 1954, pp. 138-154). As presently interpreted, the outlines reflect uneven periods of flux and convergence from about A.D. 1000 to 1800. Only recently have usable taxonomy and synthetic statements appeared utilizing the raw data to advantage (e.g. Lehmer and Caldwell, 1966, pp. 511-516; Wood, 1967, pp. 116-168). In this article a small amount of the data is used to identify certain relationships.

The purpose of this study is to construct a plausible temporal model of certain Arikara villages primarily on the basis of archeological evidence. From this model, relative temporal placement of individual villages can be deduced for further interpretation. The villages are all components of the Bad River phase (Hoffman and Brown, 1967, pp. 323-343; Lehmer and Jones, 1968), one facet of 18th century Arikara material culture along the Missouri River in present-day South Dakota. The Bad River phase is only a portion of known Arikara settlements and the villages selected for this study comprise about a third of the known phase components.

All communities are relatively small, compact horticultural and hunting villages of circular earthlodges, some fortified and some not. They are located within the narrow confines of the (former) Missouri River trench between the mouths of the Grand River and Chapelle Creek, a distance of roughly 150 miles (Figure 1). This area is now inundated by Oahe and Big Bend Reservoirs. Selection of the villages was on the basis of data immediately available to me, mostly in unpublished form. A further point of selection was

## ANTHROPOLOGY

the presence of at least 200 sherds in each site of Stanley Braced Rim Ware (Lehmer, 1954, pp. 42-46), the indicator used for this seriation, the minimal number I felt was necessary for quantitatively adequate samples. Also, the high frequency of Stanley Braced Rim Ware within the pertinent sites presented a body of material presumably sensitive to statistical manipulation for the purpose of temporal interpretation. Spatial position of the eight sites finally selected is shown on Figure 1. These are Red Horse Hawk (39CO34; Bowers, 1963, p. 118), Coleman's (39SL3), Buffalo Pasture and Indian Creek (39ST6 and 39ST15; Lehmer and Jones, 1968, pp. 3-73), Dodd and Phillips Ranch (39ST30 and 39ST14; Lehmer, 1954, pp. 2-114), Fort George (39ST17; Hoffman, 1965, pp. 46-47), and Chapelle Creek (39HU60; Brown, 1965, pp. 48-49). For purposes of tabular economy I have dropped the site names in favor of trinomial designations. Many of these sites are multi-component and it should be stressed that only the upper component or protohistoric Arikara occupation of each is used for this paper.

The selected villages are very closely related in terms of material culture, a statement clearly reflected in the pottery assemblages. One criterion of the Bad River phase is a high proportion of Stanley Braced Rim Ware in component assemblages. The percentages of this utilitarian pottery used in the present sample range from 80.46 at 39CO34 to 94.02 at 39ST30 (Table 1). At this point it must be explained that the percentages of Table 1 are largely my own based on re-analyses of either the published material or the actual collections. For instance, the high figure at 39ST30 is based on all Stanley rims found at the site rather than those statistically associated with the top component in the original report, since twenty years of experience have shown that Stanley ware cannot possibly associate with the prehistoric levels at that particular site. Again, the figures for 39ST6 include a grouping I firmly believe to be Stanley ware (Hoffman 1970), although it was not identified as such by the original investigators. Based on the proportions of Stanley ware, as shown in Table 1, to other pottery categories within the various assemblages, the close relationship of the components is emphasized by a standard deviation of only 4.36.

I have taken further liberties with the listing of Stanley rim types. The original ware definition included Stanley Cord Impressed, Stanley Tool Impressed, Stanley Plain, and Stanley Wavy Rim (Lehmer, 1954, pp. 42-46). The latter type was later termed Stanley Pinched (Lehmer and Jones, 1968, pp. 26-27). There are certain operational difficulties in distinguishing Stanley Plain from Stanley Pinched, especially when dealing with small fragments as one must with Northern Plains potteries. The occasional presence of polygonal vessel orifices, subtleties of rim distortion in Stanley Pinched, and occasional presence of pouring spouts in Stanley Plain often make distinctions difficult. In contrast, cord impressed and tool impressed styles are more readily identified although their decorative attributes are occasionally mixed.

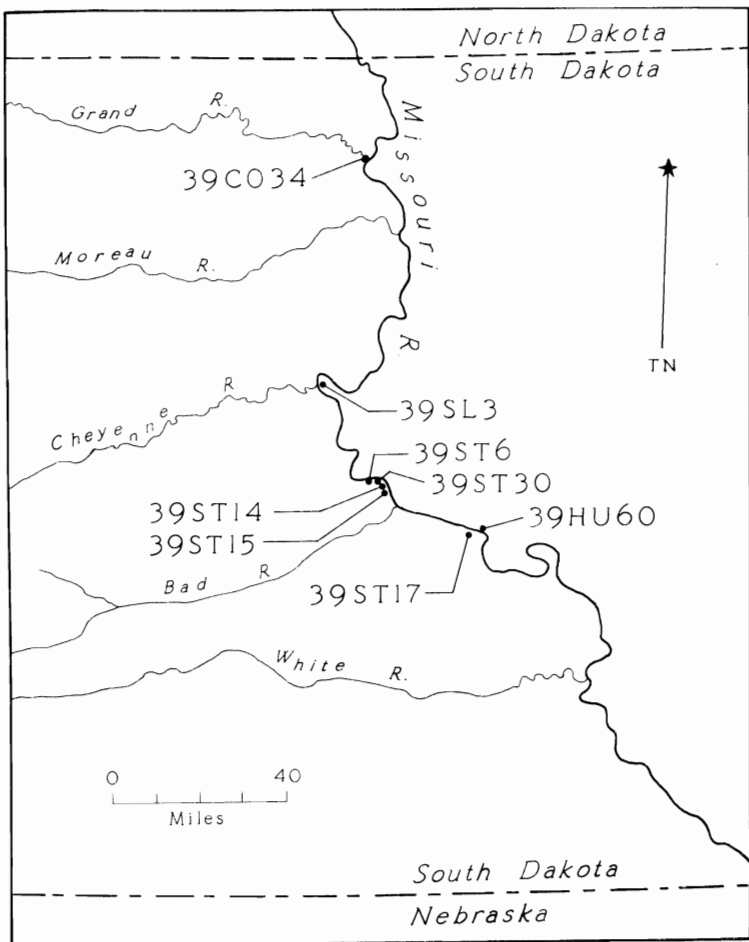


Figure 1: Location of seriated villages.

I prefer to avoid the Plain/Pinched difficulties by simply lumping the two styles into one group (Table 1).

The means of ordering the villages is a matrix of Robinson's (1951, pp. 296-297) coefficients of agreement based on proportional type differences as rationalized by Brainerd (1951, pp. 301-307); the "Brainerd-Robinson Technique." In this case the "types" are the three Stanley rim groups listed on Table 1. For purposes of the argument the groups are held to be discrete combinations of attributes derived from patterned behavior that are capable of reflecting culture change which can be measured by time or space. The basic assumptions here are the same as with most seriations in that social mechanisms of culture change are unrealistically held to be static or

# ANTHROPOLOGY

Site	Percent of Stanley in Collection	Total Stanley Rims	Percent of this Sample	Stanley Rim Style Percentages		
				Cord Impressed	Tool Impressed	Plain and Pinched
39ST17	83.06	255	4.74	26.27	57.25	16.48
39CO34	80.46	486	9.04	15.63	10.69	73.68
39ST6	84.77	1759	32.72	27.23	18.30	54.47
39SL3	85.81	236	4.39	26.27	31.78	41.95
39ST15	84.18	378	7.03	36.24	37.83	25.93
39ST14	90.61	1438	26.75	31.08	26.56	42.36
39ST30	94.02	582	10.83	20.27	25.42	54.31
39HU60	91.32	242	4.50	39.25	15.28	45.47
mean =	86.78	672	12.50	27.78	27.89	44.33
SD =	4.36	175	10.26	7.22	13.83	16.53

**Table 1: Basic ceramic data of seriated villages.**

unknown, but are presumed to be measurable. As will be shown, these assumptions are not wholly unrealistic due to the short period of time involved.

Coefficients of agreement between any two sites are determined by finding the differences between proportions of the three rim groups and subtracting the sum from 200; the latter being the maximum possible or perfect agreement. This operation and the construction of the matrix are simple mechanics familiar to most American archeologists. The sticking point of any such matrix is the ordering of indices into a rational pattern that can be interpreted as reflecting change. Again the operation is familiar to most. The ideal is to arrange the components so that their coefficients of agreement will increase horizontally and vertically towards the diagonal; the latter being composed of the indices of perfect agreement. With a full matrix, indices on both sides of the diagonal are numerically and positionally identical. The customary means of arranging the components to approximate an ideal matrix is to total the columns of coefficients and manipulate the columns to affect an ascending-decending pattern of marginal totals (Robinson, 1951, pp. 294-295). I have used a different means of arrangement in order to test an hypothesis involving chronology as well as increase the internal coherency of the matrix.

# ANTHROPOLOGY

Ordering of indices between the selected Arikara villages did not present a major problem. The known history of 18th and early 19th century Arikara is one of northward movement up the Missouri River (Wedel, 1955, pp. 77-81). As a broad generality, the more northern sites are the later sites, but exceptions exist. Inspection of pottery percentages on Table 1 offers a definite clue for initial ordering. The northernmost of selected sites, 39CO34, also exhibits that largest single percentage of any listed rim group, the Plain and Pinched group makes up 73.68% of Stanley Ware at this site. It was reasonable to suspect that 39CO34 was late in the proposed sequence, due to its northerly location, and thus to hypothesize that the Plain and Pinched group at this site represented one end of a continuum. Components were arranged on the basis of this hypothesis and the resultant flow of indices made up the matrix shown on Table 2. The relatively consistent patterning of the matrix indices appears to be a reasonable confirmation of the hypothesis and a plausible model for further manipulation.

There are six disconformities within the matrix, all attributable to a single component. In his original exposition Robinson sought a means of checking the validity of a matrix, a measure to express the difference between real and ideal patterning of the ordered indices, noting that there appeared to be no good theoretical grounds upon which such a measure could be based. Nevertheless, he suggested a numerical manipulation that expressed the percent of error within a given matrix. I have used Robinson's suggestion, formulated on Table 2, to arrive at a computed error of 10.3% which I am willing to accept as validating the model.

	39CO34	39ST6	39ST30	39HU60	39ST14	39SL3	39ST15	39ST17
39CO34		161.58	161.26	143.58	137.36	136.54	104.50	85.60
39ST6	161.58		185.76	175.96	175.78	173.04	142.92	122.10
39ST30	161.26	185.76		(162.04)	176.10	175.28	143.24	124.34
39HU60	143.58	175.96	(162.04)		177.44	(167.00)	154.90	(116.06)
39ST14	137.36	175.78	176.10	177.44		189.56	167.14	138.62
39SL3	136.54	173.04	175.28	(167.00)	189.56		167.96	149.06
39ST15	104.50	142.93	143.24	154.90	167.14	167.96		161.16
39ST17	85.60	122.10	124.34	(116.06)	138.62	149.06	161.16	

Table 2: Matrix of ordered indices based on ceramic data. Indices in brackets are disconformities that disrupt the matrix flow.

Matrix error =  $\frac{\sum(d_i^2)}{\sum(i^2)} = 10.29991\%$ ;  $\underline{d}$  is disconformities and  $\underline{i}$  is non-perfect indices.

## ANTHROPOLOGY

An attempt to form a matrix of indices based on mean standard errors, as per Lehmer's (1951, p. 151) critique of Robinson, failed to yield a rational patterning. By using indices derived from mean standard errors and the component order of Table 2, I arrived at a computed matrix error of 45.8%. It is evident that Robinson's coefficients of agreement provide the more useful indices for purposes of this study. This is because indices derived from mean standard errors produce the same effect as the Pearsonian  $r$ , originally shunned by Robinson, because, "... the correlations are all so large and so homogenous in value that they do not adequately distinguish between series showing very different degrees of agreement" (Robinson, 1951, p. 297).

The component order within the matrix of Table 2 does not indicate spatial arrangement as a glance at the map on Figure 1 shows. Although 39CO34 is the northernmost site and also lays at one extremity of the matrix, the southernmost site is 39HU60 which is positioned at the center of the matrix. Site 39ST17, positioned at the other extremity of the matrix, is appreciably north of 39HU60. Matrix positions of 39ST6, 39ST30, 39ST14, and 39ST15 coincide with their relative spatial arrangement in the locality above the Bad River mouth. But any spatial interpretation of the entire matrix is negated by the matrix position of 39SL3, far north of the Bad River. Considering the spatial data and the component ordering within the matrix, I am suggesting the plausibility of the matrix as a temporal model of the selected Arikara villages.

Unfortunately, the matrix does not indicate which end is up. It is evident that the Plain and Pinched pottery group underwent frequency changes through time, but in which direction? I have only assumed 39CO34 to be the latest site for purposes of ordering the indices. The assumption can be strengthened by a rather circuitous review of known Arikara history in this particular area.

The last Arikara settlement below the mouth of the Cheyenne River was actually two adjacent villages described in the journal of the trader J. B. Trudeau or Truteau in 1795 (Nasatir, 1952, pp. 259-311). These villages are now known to be sites 39ST25 and 39ST50 (Lehmer and Jones, 1968, p. 83), data from which were not immediately available for this study. Internal evidence in Trudeau's journal indicates that this settlement was founded in 1793, at the latest, and was the only active Arikara village in that sector of the Missouri trench, as well as the only settled village for a distance of 75 miles above and 125 miles below, as of 1795. The settlement was abandoned in 1797 and, after a short period in North Dakota, the Arikara returned south and built their last South Dakota villages sometime before 1804 above the mouth of the Grand River (Coues, 1893, p. 104). Therefore, one may safely conclude that the historically undocumented sites of this seriation must date before 1793, specifically including 39CO34 at the mouth of the Grand River.

## ANTHROPOLOGY

In view of the historic northward movement of the Arikara, it is reasonable to believe that site 39CO34 is the latest of the seriated components. The inverse proposition, in terms of the matrix, that site 39ST17 is the latest, is not persuasive due to its location near the southern terminus of the distribution. It must be remembered that the seriated villages are only a selection of known Arikara sites, Bad River phase and others. Our understanding of Middle Missouri archeology indicates that virtually all protohistoric Arikara sites are north of 39ST17. The endpoint of the argument is that the matrix on Table 2 represents a logical ordering, from early to late, of selected sites dating before 1793.

One of the stated goals of this paper is to deduce the relative temporal placement of the individual villages. I have done this by the arbitrary device of determining the mean distance between sets of sites as derived from the indices of Table 2 and expressing the distances as single numbers. The device assumes that the individual indices reflect real units of culture change between any two sites in relation to all other sites of the matrix. The technique consists of finding individual differences between shared indices of a set of two sites, adding the differences and dividing the resultant sum by the number of indices shared by the set. This I call the mean distance; it is simply an abstraction of Robinson's original coefficient of agreement, and distances are determined for all sites on a set-by-set basis. Unlike the formula used to check matrix validity, the computations of mean distances include indices of perfect agreement. In other words, each blank space along the diagonal of Table 2 is replaced by the index 200.00 for purposes of determining differences between shared indices of a set and, thus, arriving at a single number that expresses distance between the sites of a given set.

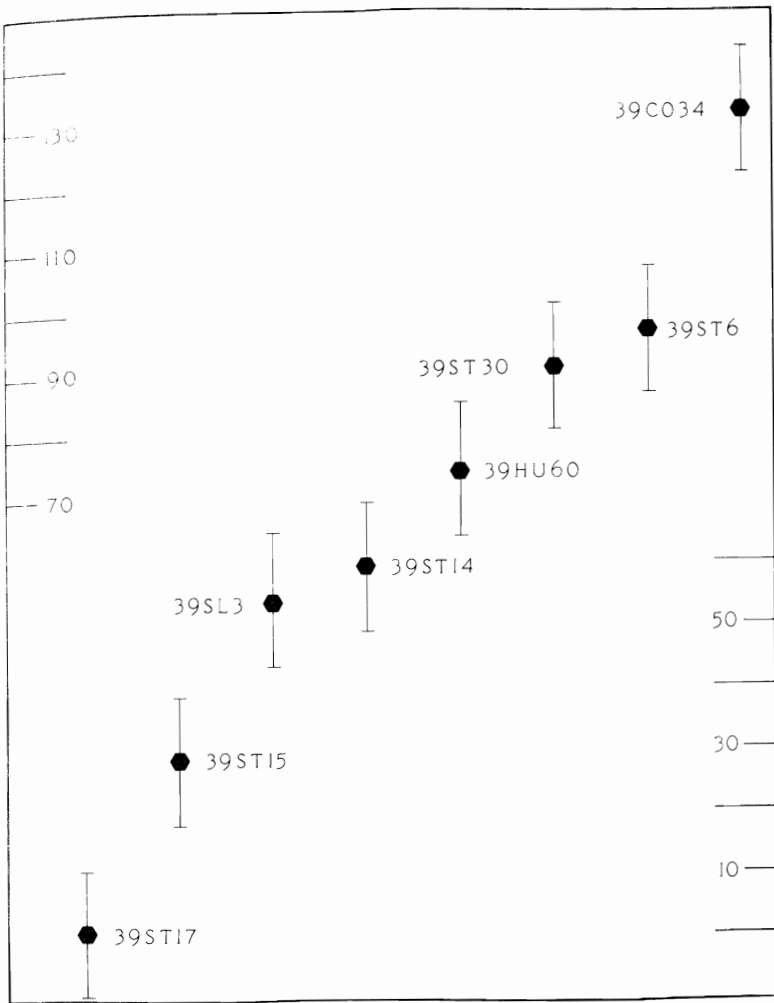
By using the order shown on Table 2 and the abstracted mean distances, the individual villages are arranged as shown on Figure 2. The earliest component, 39ST17, is arbitrarily assigned a value of zero and succeeding components carry higher values reflecting their distances from the zero point.

I know of no mathematical rationale for this operation. It is merely a means of determining relative temporal placement on the assumption that the manipulated data express intrinsic values that can be abstracted as single numbers. Thus, I can say that villages 39ST30 and 39ST6, for example, are separated by 5.98 units of mean distance remembering that the units are ultimately derived from the ceramic data. Like the matrix indices, the derived units reflect culture change which is measured temporally rather than spatially as previously interpreted from the matrix.

Each village plotted on Figure 2 carries a standard deviation. I have chosen to do this because of the unequal size of the selected pottery groups. Referring back to Table 1 it is seen that there are sufficient quantitative differences between the various Stanley ware assemblages in the matrix sample as to introduce an element of uncertainty into the



# ANTHROPOLOGY



**Figure 2:** Relative temporal placement of seriated villages as derived from matrix of indices. Vertical scale indicates units of mean distance between villages.

temporal placement of individual sites. In the fourth column of Table 1 these differences are expressed as percentages of the total sample that carry a standard deviation of 10.26. This figure is the 1-sigma range attached to each village plot shown on Figure 2.

As a partial check on the above results I have also seriated the selected villages by means of M. Ascher's (1959, pp. 212-214) modification of Meighan's (1959, pp. 203-211) tripole graphic seriation. Graphic seriation is based on the premise that culture change between similar components can be

## ANTHROPOLOGY

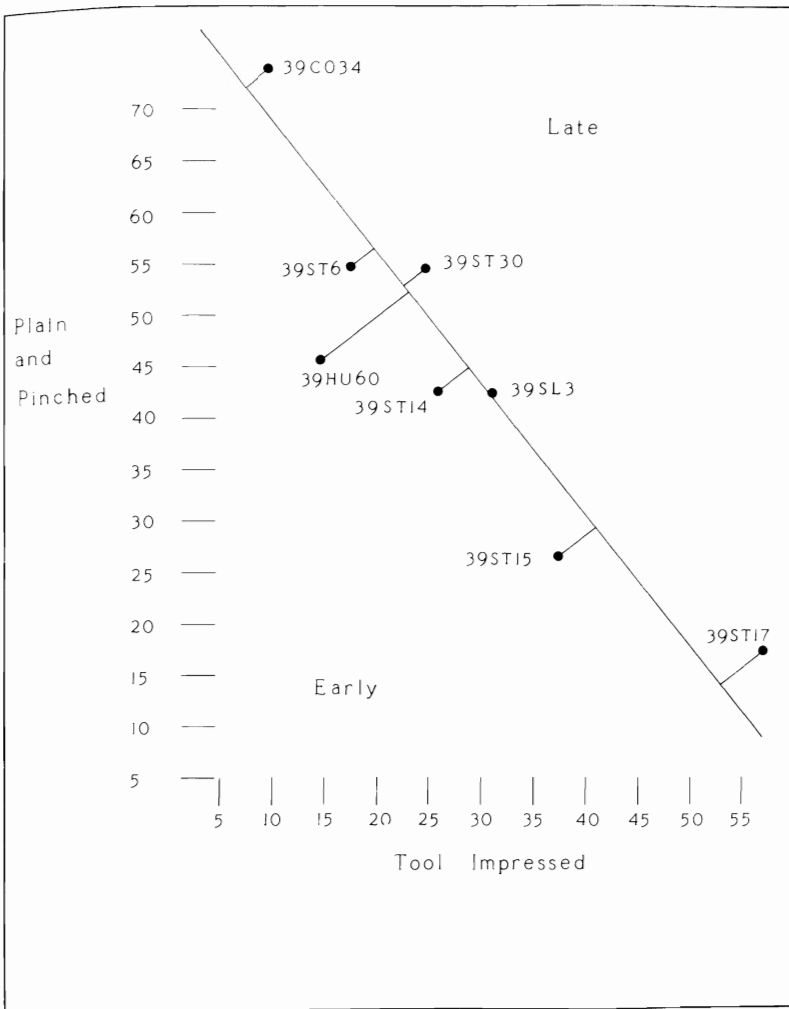
temporally measured by the numerically plotted intersection of abundant, measurably diverse, and (presumably) significant traits. In practice, this usually means percentage distributions of pottery types. In Ascher's dipole modification percentages of two, presumably sensitive types are plotted on an x-y axis for each component. A "best-fit" line is drawn through the plotted points and a perpendicular is drawn from each point to the "best fit" line in order to graphically portray the sequence of selected components. A recent, practical example of this method is Vis and Henning's (1969, pp. 253-271) seriation of Mill Creek components in the Little Sioux Valley of northwestern Iowa.

For the ordering of Arikara villages on an x-y axis I selected the Stanley Plain and Pinched, and the Tool Impressed groups. These groups show the largest standard deviation among the selected components (Table 1) and are assumed to be the more temporally sensitive. Results of the plotting and the "best fit" line are shown on Figure 3 wherein the component order is identical to that of the matrix and the matrix-derived temporal placement on Figure 2. The "best fit" line of Figure 3 is a subjective judgement, in keeping with Meighan's original method, that simply splits the ordered villages into two numerically equal groups. I have rejected Ascher's suggestion of fitting a line to the points by means of a least squares "best fit." Such technique requires linear regression predicated upon more precise data than I believe may be derived from a group of potsherds. Linear regression also predicates an exactness of linearity that I do not believe to be inherent in Arikara ceramics or, for that matter, few tangible products of human behavior. The lack of exactness in the present case is demonstrated by the scattering of plotted points about the "best fit" line of Figure 3 as well as the matrix-derived S-curve described by the ordered villages on Figure 2.

## DISCUSSION

As a result of the ordering of the selected villages the Stanley pottery groups used for ordering can be placed in temporal perspective. Figure 4 illustrates the percentage distributions of the three groups arranged from early to late by means of the component seriation. As hypothesized, the Plain and Pinched group shows quantitative increase through time. The steady increase is at the expense of the Tool Impressed and Cord Impressed groups. The concurrent decrease of Stanley Tool Impressed is fairly regular except at site 39HU60. Temporal distribution of Stanley Cord Impressed is somewhat erratic with a definite peak at 39HU60. Referring back to matrix of Table 2 it can be seen that site 39HU60 also disrupted the flow of indices thereby lowering the internal consistency of the matrix. Evidently there is something in the data or selection of the data from this component that is less than ideal.

# ANTHROPOLOGY



**Figure 3: Graphic seriation of the selected villages. Axis scales are ceramic percentages based on total Stanley rims of each village.**

Previously it was mentioned that the assumption of social stasis of the mechanisms of culture change measured in these seriations was not wholly unrealistic. The chronological considerations suggest that no more than three generations are represented by the time span of the selected villages. For instance, it has already been established that the villages were occupied sometime before 1793. The initial date of the sequence depends on site 39ST17; the earliest village of both seriations. This site is the only component of the Bad River phase that has been objectively dated, insofar as it is

# ANTHROPOLOGY

presently possible, on the basis of denrochronological readings made from juniper and ash specimens taken from lodge remains. The latest date is 1723vv (Weakly, 1967, p. 122). This is not a cutting date and Weakly explains the vv symbol as meaning, "... there is no way of estimating how far the last ring is from the true outside" (Ibid.). However, the dated specimens are all small, the largest having only 101 counted rings, and Weakly's terminal dates are probably quite close to reality. I prefer to view the total time span of the villages as about 60 years, from approximately

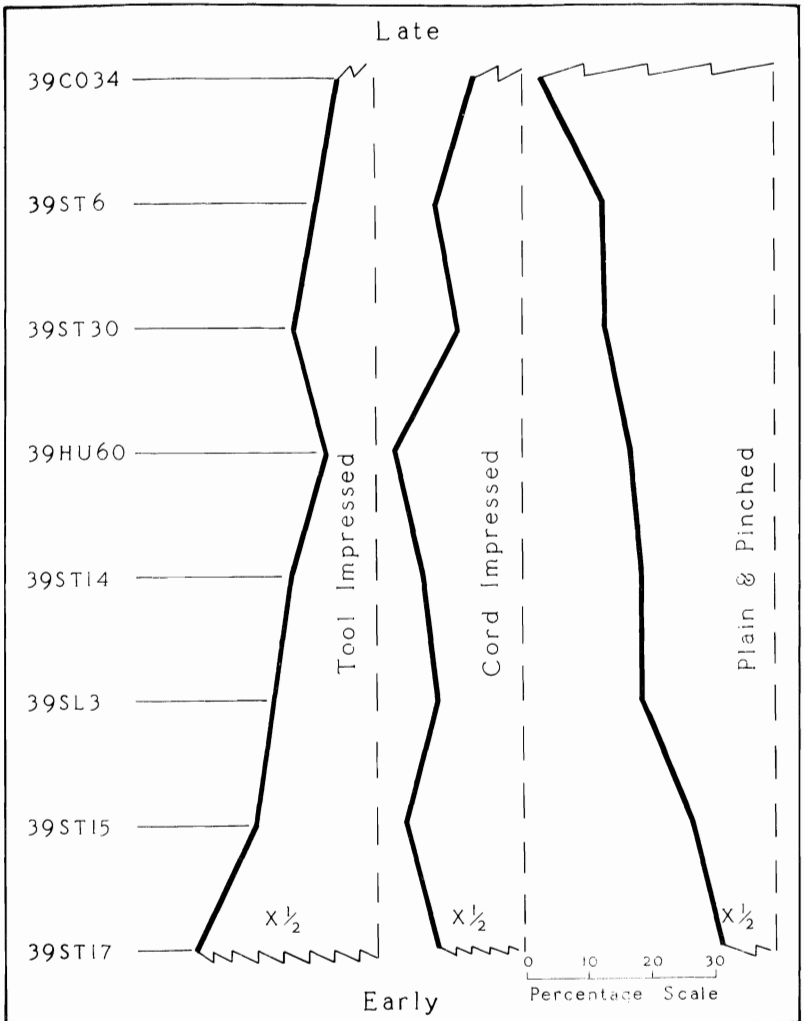


Figure 4: Temporal distribution of Stanley rim groups among seriated villages. Each graph is a lateral half of the actual distribution.

1730 to approximately 1790. While social changes undoubtedly occurred during even this short period of time, I find it hard to imagine drastic changes in basic pottery attributes during three generations of villagers. We know, for example, that 19th century Arikara villages, postdating those of this sequence, continued making Stanley ware.

The endpoint of all these manipulations is to present a temporal model of certain Arikara villages based on presumably sensitive traits. The model I present is not the only one available nor does it fully agree with previous ideas on the dating of Arikara villages. Recently a seriation of selected Arikara villages was presented at the 27th Plains Anthropological Conference (Pollnac and Pollnac, 1969). This seriation used some villages I have not used and vice versa. The Pollnacs' arrangement is derived from a rather elegant Q-factor analysis of multiple ceramic attributes including potteries other than Stanley ware. Our disagreement centers on four villages common to both seriations. In terminal dates they rank (from early to late) 39ST30, 39ST14, 39ST6 and (with intervening components) 39CO34. This is slightly different from the model I present and more ambitious in scope. The Pollnacs also assign calendrical dates to individual village time spans. For instance, they calculate that site 39ST14 was occupied from about 1725 to 1745, and site 39ST30 was occupied from about 1720 to 1737. I am unable to obtain such fine measurements with my methods.

In the original definition of the Bad River phase, the authors were unable to distinguish adequate evidence for splitting of the phase into subunits (Hoffman and Brown, 1967, pp. 335-336). A later discussion of the unit by Lehmer and Jones (1968, pp. 95-100) split it into subphases Bad River 1 and 2. This split is in keeping with Lehmer's (1954, pp. 118-134) earlier thoughts on the Stanley and Snake Butte foci, the literary and taxonomic forebears of the Bad River phase. The subphase definitions place Bad River 1 at about 1675 to 1740 and Bad River 2 at about 1740 to 1795. The salient material differences between the subphases (and the apparent basis for dating) are a lack of fortifications, horse remains, and gun parts in Bad River 1. By these differences Lehmer and Jones place sites 39ST30 and 39ST15 into Bad River 1, and sites 39ST14 and 39ST6 into Bad River 2.

Elsewhere I have argued against splitting of the phase on the basis of the above factors (Hoffman, 1970, p. 115). This is not to say that subunits cannot be derived from the phase, but only that a logically consistent means of doing so has yet to be devised. If there is any validity to the temporal scheme I present here (or to the results of the Pollnac scheme for that matter) then the probability is nil that individual villages can be temporally assigned with any confidence on the basis of the presence or absence of fortifications, guns, and horses. A glance at the data of Table 3 confirms this. While neither the earlier nor later known Arikara sites are included in this list, the erratic

## ANTHROPOLOGY

Component	Fortifications	Horse Bones	Gun Parts or Associations
39C034	yes	no	native-made flints only
39ST6	yes	no	yes
39ST30	no	no	no
39HU60	yes	no	no
39ST14	yes	yes	yes
39SL3	no	no	no
39ST15	no	no	no
39ST17	yes	yes	yes

**Table 3: Occurrence of supposed temporally sensitive traits among the seriated Bad River phase components.**

occurrence of supposedly temporal traits certainly questions their sensitivity. It is evident that we are dealing with a closely related series of villages, spanning a short period of time, villages that had differential access to (or acceptance of) certain outstanding trade items, and villages that had differing defensive needs. Thus, I view the differing frequencies of Stanley rim groups between villages with high proportions of this material as being the more sensitive and reliable of temporal criteria.

## CONCLUSION

On the basis of the temporal models presented here, I interpret a sequence of Bad River phase Arikara villages dating about 1730 to 1790. The sequence is not necessarily linear: indeed, some of the selected villages may be contemporary as indicated by the abstractions of Figure 2. I interpret the changing proportions of Stanley Braced Rim Ware through the sequence as being more temporally sensitive than any previously identified factors. These simplistic interpretations differ somewhat from previous works on the subject, as do the models used in this interpretation. Moreover, my manipulation and abstraction of the data differ slightly from the usual means of manipulation. Thus, the analytic devices employed here are not ideal models in that they do not rigidly conform to established means of constructing such models. I find this situation desirable since I have the same suspicious regard for ideal models as I have for ideal human behavior.

## ANTHROPOLOGY

However, I refuse to plead guilty to methodological naivete; I am interested in what is credible as opposed to what is formally elegant. It must be remembered that the various tables and figures of this article are logical constructs; merely analytical tools to be used or not used as the occasion warrants. No matter how it is manipulated, the basic commodity discussed here remains exactly 5,376 pieces of fired clay.

My attitude is best summed by Bayard's recent statement that, "... models describing objective reality are simply utilitarian, explanatory abstractions not related to such concepts as absolute truth and absolute reality." (Bayard, 1969, p. 376). While I do not accept all of Bayard's apparent attitudes regarding the use of statistical models, I do believe that such methods are best kept in utilitarian perspective. Either they work credibly, with or without modification, or they are discarded for alternative logical means. The seriation of Arikara villages that I present here is one logical means of viewing a particular archeological situation.

## ACKNOWLEDGEMENTS

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